Interactions between *koi herpes virus* (KHV) transmission and management of invasive common carp (*Cyprinus carpio*)

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INTRODUCTION

Background: Managers have been working to reduce the impacts of common carp for decades, and KHV has been proposed for biocontrol of invasive common carp in Australia.[1] During summers 2017 and 2018, 27 common carp mass mortalities were reported, the majority of which were in southern MN, and KHV was confirmed in 13 of these mortality events.[2]

Research Question: How does KHV impact the population of common carp in a lake and how might it be used to enhance current control strategies?

METHODOLOGY

Lake Elysian, Waseca County, MN, consist of a main lake (~896 hectares) connected to an outlet marsh. This study's model is based on Lake Elysian because of its prototypical lake-marsh connection and access to 2020 Lake Elysian water temperature and common carp data. Lake-marsh connections are of particular interest since common carp adults tend to migrate between lakes and outlying marshes to spawn annually.

Simulation model: Demographic changes, including recruitment, maturation, migration, are implemented in a deterministic fashion using rates or functions derived from the literature. Changes in disease states are evaluated using the compartmental model displayed in Fig. 1.

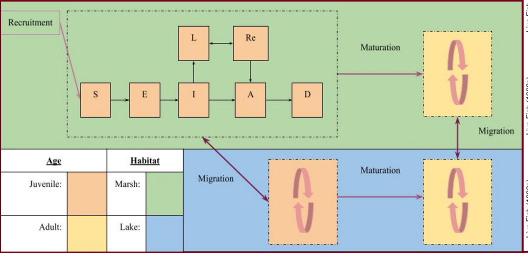

Fig. 1. KHV transmission occurs per compartmental model. Recruits join as susceptible class and fish move between groups via migration and maturation. S - Susceptible; E - Exposed; I - Infected; A - Ailing; L - Latently Infected; Re - Recrudescent

Fig. 2. Spring-Fall Timeline. Water temperature data collected from Lake Elysian in 2020 used to fit sine curve in MATLAB. KHV transmission and certain demographic dynamics simulated in daily time steps from March 19 to December 21. Winter kills happen in a single 'Winter' step per binomial distribution with probability 0.7.

RESULTS

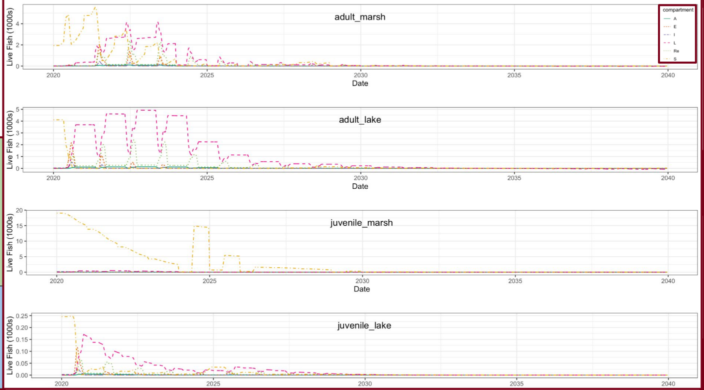

Fig. 3. Total number of live fish in each disease state compartment 20 years post-introduction of KHV infected individuals. Adults in the lake; adults in the marsh; juveniles in the lake; juveniles in the marsh. S - Susceptible; E - Exposed; I - Infected; A - Ailing; L - Latently Infected; Re - Recrudescent

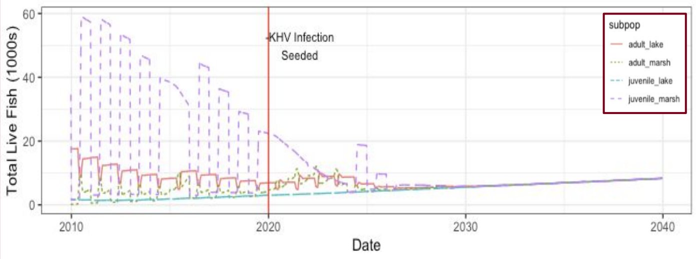

Fig. 4. Total number of live fish in each subpopulation pre- and post-introduction of KHV infected individuals over a 30 year time period. Adults in the lake; adults in the marsh; juveniles in the lake; juveniles in the marsh. Simulation is started and then KHV infection is seeded at year 10 as 1% of the population.

DISCUSSION

Preliminary Conclusion: Figures presented are preliminary results. Declining populations pre-seed of KHV suggests parameters need adjusting to create a self-sustaining baseline. A decrease, then gradual increase in population post-seed of KHV suggests at least short-term population reduction.

Next Steps: Parameters are to be evaluated to ensure baseline model's robustness, and management strategies such as baiting or seining are to be simulated and compared against baseline model outcomes.

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